LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

LIGO Laboratory / LIGO Scientific Collaboration

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Test Procedure for RF Frequency Difference Mixer

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1 Introduction

The following Test Procedure describes the test of proper operation of the Frequency Difference Mixer. The unused RF outputs should always be properly terminated with a 50Ω resistor.

S/N ____________________ Tester ______________ Date __________________

2 Test Equipment

- Voltmeter
- HP 4395A Network/Spectrum/Impedance Analyzer
- Stanford Research SR785 Analyzer
- Tektronix AFG3101 function generator
- RF Power Meter Agilent E4418A
- RF Frequency counter Agilent 53131A
- Board Schematics, LIGO D1600499 / D0901846 / D1000064
- Multiple Frequency Oscillator, LIGO D1100663
- 90deg SMA-to-BNC adapter

3 Tests

1) **Verify the proper current draw.** Using a bench DC supply apply +- 24Volts to P7 and +- 17 Volts to P6 of the low noise power Module (D0901846). Measure the current draw of the board.

+24 Volt current ___________ 0.02 A Nom.

-24 Volt current ____________ 0.03 A Nom.

+17 Volt current ___________ less than 1.1 A, 0.65 A Nom.

-17 Volt current ___________ less than 0.1 A, 0.03 A Nom.

2) On the low noise power module check the voltage on TP 1-13.

TP1 (+17V) ______________ TP2 (-17V) _______________

TP3 , 4 (GND) TP5 (+ 5V)________________

TP6 (-15V) ________________ TP7 (+24V) ________________

TP8 (GND) TP9 (-24V) ____________________

TP10 (GND) TP11 (+15V) ____________________

TP12 (+VREF) _____________ TP13 (-VREF) ____________________

3) If TP 1 , 2, 7 , 9 and 8 are correct then pin 5 on U1 and U7, (OK, TP14) should be Logic high ~3Volts. Confirm.____________________

4) The noise on TP 12, 13, 11 and 6 should be measured with a SR785 using an rms power spectrum.

TP12 noise ____________________less than 20 nVrms/sqrt Hz at 140 Hz

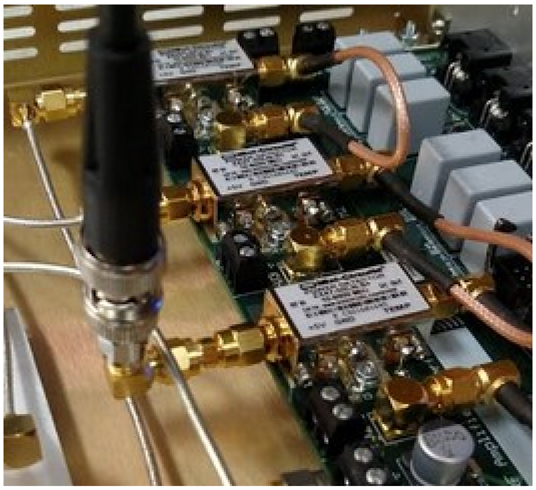
TP13 noise _____________________less than 20 nVrms/sqrt Hz at 140 Hz

TP11 noise _____________________ less than 20 nVrms/sqrt Hz at 140 Hz

TP6 noise ______________________ less than 30 nVrms/sqrt Hz at 140 Hz.

5) **Test the power monitors by applying an rf signal through to each of the ZX47 RF detectors at the frequency which they'll receive "in-circuit".** Measure the output voltages mon1, mon2 and mon3 and, with an RF power meter, measure the RF power applied to the detector input.

An image is shown below:



M1

Frequency	Nom input pwr	Measured Pwr dBm	Monitor Voltage (M)	Measured Volt
3.125 MHz	+10 dBm		0.61	
3.125 MHz	+5 dBm		0.70	
3.125 MHz	0 dBm		0.82	
3.125 MHz	-5 dBm		0.94	
3.125 MHz	-10 dBm		1.07	

M2

Frequency	Nom input pwr	Measured Pwr dBm	Monitor Voltage (M)	Measured Volt
45.5 MHz	+10 dBm		0.61	
45.5 MHz	+5 dBm		0.71	
45.5 MHz	0 dBm		0.83	
45.5 MHz	-5 dBm		0.96	
45.5 MHz	-10 dBm		1.09	

M3

Frequency	Nom input pwr	Measured Pwr dBm	Monitor Voltage (M)	Measured Volt
42.375 MHz	**+10 dBm**		**0.62**	
42.375 MHz	**+5 dBm**		**0.72**	
42.375 MHz	**0 dBm**		**0.83**	
42.375 MHz	**-5 dBm**		**0.96**	
42.375 MHz	**-10 dBm**		**1.08**	

We now move on to the full assembly of the Frequency Difference (D1600499).

6) **The purpose of the board is to find the difference between the input frequency and the reference frequency.**

   Measure RF powers and RF frequencies.

   Hook a 10dBm/45.5 MHz REF source (from the signal generator) to the "REF" input.

   Hook a 10dBm/3.125 MHz REF source (from the MFO) to the "IN" input. The MFO output will require an attenuator to get it to ~10dBm, as shown below:

   Measure the output power of the attenuated MFO signal: _________dBm

   Measure the outputs (and their harmonics). Calculate dBc versus power at 42.375 MHz.

Port	Power (dBm)	dBc	Nominal
O1		**---**	>13 dBm at 42.375 MHz
O1			< -40 dBc at 84.750 MHz
O1			< -40 dBc at 127.125 MHz

Port	Power (dBm)	dBc	Nominal
O2		---	>13 dBm at 42.375 MHz
O2			< -40 dBc at 84.750 MHz
O2			< -40 dBc at 127.125 MHz

Capture an image of the spectrum around 42.375 MHz and insert it here:

<INSERT IMAGE HERE>

7) **Find the noise floor of the output assembly.** First, calculate the average of O1 and O2's power measurement at 42.375 MHz: _______ dBm.

Now you will measure the noise floor at given frequencies. First, remove the IN signal but keep the 45.5 MHz signal connected and operating. Next, terminate any unused input or output ports on the chassis with 50Ω. Using the HP spectrum analyzer, 0 dB attenuation and at least 10 averages, measure the noise floor at the input and output frequencies. Calculate dBc against the O1/O2 reference above.

O1

Frequency	Power (dBm/Hz)	dBc/Hz	Nominal
3.125 MHz			**< -100 dBc/Hz**
45.5 MHz			**< -100 dBc/Hz**
48.625 MHz			**< -100 dBc/Hz**

O2

Frequency	Power (dBm/Hz)	dBc/Hz	Nominal
3.125 MHz			**< -100 dBc/Hz**
45.5 MHz			**< -100 dBc/Hz**
48.625 MHz			**< -100 dBc/Hz**

Reconnect the IN input (3.125 MHz) and measure again at one of the two outputs. Take 100 kHz offset frequency measurements. This time, capture images at each of the target center frequencies. Again, calculated dBc based off of the O1/O2 average above.

O1/O2 Freq. (MHz)	Power (dBm/Hz)	dBc/Hz	Nominal
3.025			< -100 dBc/Hz
3.125			< -100 dBc/Hz
3.225			< -100 dBc/Hz
45.4			< -100 dBc/Hz
45.5			< -100 dBc/Hz
45.6			< -100 dBc/Hz
42.275			< -100 dBc/Hz
42.375	---	---	---
42.475			< -100 dBc/Hz
48.525			< -100 dBc/Hz
48.625			< -100 dBc/Hz
48.725			< -100 dBc/Hz

Insert the three input signal images below.

<INSERT 3 IMAGES HERE>

8) **Finally, determine what the dominant two sidebands near 42.375 MHz are.** Given the signal differences, the HP is likely to saturate, so allow the attenuation to be automatic. Set a 20 MHz span around the output frequency and record the frequency and power of the two largest sidebands (it is highly likely that these will fall on 45.5 MHz and 48.625 MHz).

Frequency (MHz)	Power (dBm)